

POLYBUTYLENE TEREPHTHALATE AND POLYBUTYLENE NAPHTHALATE TUBULAR STRUCTURES

RELATED APPLICATIONS

This application is a continuation-in-part of U. S. Pat. Appln. S.N. 09/951,181 filed Sept. 13, 2001.

BACKGROUND OF THE INVENTION

The present invention relates to the field of polymeric hoses, and particularly to the field of flexible polybutylene terephthalate or polybutylene naphthalate hoses. Rubber hoses are generally used in a variety of uses such as automobile fuel feed hoses, fuel vent hoses, torque converter hoses, power steering hoses, air conditioner hoses, brake fluid hoses, industrial hydraulic hoses and compressed gas hoses, refrigerator hoses, garden hoses, propane gas hoses, etc.

Polybutylene terephthalate has been used as a thin barrier layer in multilayer hoses or tubes as disclosed in U. S. Pat Nos. 5,996,642; 5,910,544; and 5,474,109. Other examples of prior art patents which teach multilayer polymer hoses or tubes containing polybutylene terephthalate in one of the layers for use in fuel line applications include U. S. Published Pat. Appln. Nos. 20010037795 and 20010031330; and U. S. Pat. Nos. 5,390,705 to Brunnhofer and 6,192,942 to Hsich et al., U. S. Pat. No. 6,179,008 to Kawazura, et al. teach rubber hoses composed of an inner tube of polybutylene terephthalate. U. S. Pat. No. 5,792,532 to Pfleger discloses a corrugated hose containing a polybutylene terephthalate layer for use in automotive air conditioner or radiator lines.

It is clear that there have been many problems and many proposed solutions to the problems. However, there remains an urgent need, particularly in the automotive and industrial hose industries, for a flexible, single layer hose which is simple to manufacture using single extruder methods, eliminates the problem of delamination while maintaining manufacturing costs at an acceptable level.

SUMMARY OF THE INVENTION

The present invention provides a tubular structure formed solely of polybutylene terephthalate (PBT) or polybutylene naphthalate (PBN) for use in automotive, industrial

or domestic applications where there is no need to dissipate static electricity buildup. Since the tubular structure of the invention consists of a single layer of polybutylene terephthalate or polybutylene naphthalate, the problem of delamination is non-existent. Furthermore, the polybutylene terephthalate or polybutylene naphthalate tubular structure of the invention possesses superior strength and durability, and is resistant to heat and chemical degradation. Both polybutylene terephthalate and polybutylene naphthalate are relatively stiff materials, but are considered adequate for the purpose of this invention. In certain situations where more flexibility is desired, the polybutylene terephthalate can be built having a corrugated structure which allows additional flexibility depending upon the extent and degree of the corrugation and upon the particular use of the hose.

Copending U. S. Pat. Appln. No. 09/951,181 relates to fuel transport hoses for use in the automotive industry to transport fuel. The polybutylene terephthalate or polybutylene naphthalate is employed solely throughout the entire wall of the hose to provide reduced permeability without the need for a separate barrier layer. Typically, such polybutylene terephthalate or polybutylene naphthalate hose exhibits a fuel liquid and vapor permeation of less than about 1 g/m²/day of CE-10 at 40° C. In addition to reduced permeability, the hose has adequate strength and durability over long periods of time, and is resistant to chemical degradation by the fluids being transported therein. Since it is well known in the industry that hoses used to transport fuels are required to contain a conductive agent or otherwise exhibit conductive characteristics in order to dissipate any electrical buildup which may occur during the flow of fuel through the hose, the hose of copending U. S. Pat. Appln. No. 09/951,181 also contains therein such a conductive agent. While the single layer hose of polybutylene terephthalate or polynaphthalate exhibits all of the above desirable characteristics, it has now been found that the strength and durability of such hose which contains a conductive agent are less than the strength and durability of a polybutylene terephthalate or polybutylene naphthalate hose which does not contain a conductive agent. Therefore, it is a particular object of the present invention to provide a polybutylene terephthalate or polybutylene naphthalate hose which does not require the presence of a conductive agent in the hose.

It is another object of the present invention to provide a polybutylene terephthalate or polybutylene naphthalate hose which is useful in a variety of automotive, industrial and domestic applications.

Typically, the hoses of the present invention are useful in a variety of applications such as automobile fuel vent hoses, torque converter hoses, power steering hoses, air conditioner hoses, brake fluid hoses, industrial hydraulic hoses and compressed gas hoses, refrigerator hoses, garden hoses, propane gas hoses, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a polybutylene terephthalate or a polybutylene naphthalate tube of the present invention;

FIG. 2 is a perspective view illustrating the polybutylene terephthalate or polybutylene naphthalate hose of Fig. 1 including a protective cover;

FIG. 3 is a sectional view through the polybutylene terephthalate or polybutylene naphthalate hose of Fig. 1; and

FIG. 4 is a sectional view through the polybutylene terephthalate or polybutylene naphthalate hose of Fig. 2.

DETAILED DESCRIPTION OF THE INVENTION

In accordance with the present invention, polybutylene terephthalate or polybutylene naphthalate is employed as the sole material used to form the wall structure of a tubular structure which is useful in a variety of automotive, industrial and domestic applications. For example, the polybutylene terephthalate or polybutylene naphthalate hose of the present invention is advantageously used as a fuel vent hose, torque converter hose, power steering hose, air conditioner hose, brake fluid hose, industrial hydraulic hose and compressed gas hose, refrigerator hose, garden hose, propane gas hose, etc.

Polybutylene terephthalate and polybutylene naphthalate are relatively stiff materials and are generally not the best choice as a material for forming a tube which includes bends and turns. In one aspect of the invention, the polybutylene terephthalate or polybutylene naphthalate tube is formed having a corrugated configuration which makes the tube more flexible so that it can be conveniently shaped in any configuration desired.

With reference to the figures, Figs. 1 and 3 illustrate one embodiment of the present invention wherein the entire wall 12 of the hose 10 is constructed of polybutylene terephthalate or polybutylene naphthalate. Figs. 2 and 4 illustrate another embodiment of the invention wherein the entire wall 12 of the tube 10 is constructed of a polybutylene terephthalate or polybutylene naphthalate and the hose 10 further includes a protective cover 14 adjacent the outside surface 16 of the polybutylene terephthalate or polybutylene naphthalate wall 12. The cover 14 may be made of any material commonly used in the industry to cover a fuel tube and to provide flame resistance to the tube. Typically, the cover layer is constructed of a polymer, copolymer, blend or alloy of a thermoplastic material such as polyesters, polyamides such as nylons, polyurethanes, polyvinyl chloride, polyolefins, chlorinated polyolefins, polyalkylene terephthalate, polyalkylene naphthalates, and the like.

It may be desirable to incorporate a tie layer between the polybutylene terephthalate or polybutylene naphthalate tube and the cover. Where such tie layer is desired, any of the commonly recognized tie layers which will adhere to the polybutylene terephthalate or polybutylene naphthalate, and to the cover material will be satisfactory. Anhydride-modified linear low density polyethylenes available from Du Pont under the name Bynel®, or from Mitsui under the name Admer® are examples of two such materials.

Having described the invention in detail and by reference to preferred embodiments thereof, it will be apparent that modifications and variations are possible without departing from the scope of the invention defined in the appended claims.